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COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
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BIOLOGY AND CONTROL OF
AVOCADO INSECTS
AND MITES

HOWARD L. MCKENZIE

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CONTENTS

	PAGE		PAGE
Introduction	3	Parasites	30
Key to diaspine scales attacking the avocado in California . . .	4	Control	30
Latania scale	6	June beetles	30
History and synonymy	7	Life history	30
Distribution and hosts	7	Control	31
Life history	8	Fuller's rose weevil	31
Parasites and predators	10	Brown mite	32
Control	10	Distribution and hosts	32
Dictyospermum scale	15	Nature of injury	32
Greedy scale	15	Life history	33
Ivy or oleander scale	15	Dispersal	33
Red scale	15	Predators	34
Soft brown scale	16	Control	34
Black scale	16	Greenhouse thrips	34
Omnivorous looper	16	Description	34
History and synonymy	17	Nature of injury	34
Distribution and hosts	17	Control	35
Life history	18	Broad-nosed grain weevil	35
Parasites	20	Distribution and hosts	36
Disease of the looper	22	Description and habits	36
Control	22	False chinch bug	37
Amorbia	25	Avocado pests of lesser importance in California	37
Distribution and hosts	25	Avocado pests of the world . . .	38
Nature of injury	26	Bibliography	44
Life history	26		

BIOLOGY AND CONTROL OF AVOCADO INSECTS AND MITES^{1, 2}

HOWARD L. McKENZIE³

INTRODUCTION

THE GREATLY INCREASED PLANTING of the avocado in recent years has been accompanied by a corresponding increase in the amount of injury caused by insect pests. Some of the insects attacking the avocado are native to California and others are recorded as being of recent occurrence in the state. These pests include defoliating caterpillars and beetles, a number of scale insects (of which the rather recently recorded latania scale is the most important), the avocado brown mite, and a native species of thrips.

The insect pests attacking the avocado in Florida and foreign countries have also been included in this bulletin. In a new industry, such as the California avocado industry, it is important to know what pests occur on the same crop in other sections or countries in order that proper precautions may be taken to guard against the entrance of such insects; a complete list of these is given in a later section. Two important pests of the avocado in California, apparently, have already been introduced from other localities.

The author wishes to express his appreciation to Professor H. J. Quayle, of the Citrus Experiment Station, who directed the work reported in this paper, and who read and corrected the manuscript. Thanks are also due to Professor Harry S. Smith and to Mr. Walter Ebeling for suggestions and corrections; to Professor P. H. Timberlake for his identifications; and to Mr. D. F. Palmer, who at different times rendered assistance.

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² Paper No. 318, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

³ Laboratory Assistant in Entomology.

KEY TO DIASPINE SCALES ATTACKING THE AVOCADO IN CALIFORNIA

On account of the similarity of the diaspine scales of the avocado, especially those belonging to the genus *Aspidiotus*, it was deemed advisable to construct a key. The key, together with the illustrations of the pygidium⁴ of each scale, should make possible an accurate determination.⁵ This key has been prepared for inspectors and technical workers who are competent to make such determinations.

- A. Median pair of lobes on pygidium never more than twice as large as the second or third pair of lobes on pygidium..... *B*
- Median pair of lobes on pygidium extremely large, always three or four times as large as the second or third pair of lobes on pygidium..... *C*
- B. Circumgenital pores not present.....*Aonidiella aurantii* (Mask.) (fig. 1*B*)
- Circumgenital pores present..... *D*
- C. Circumgenital pores present.....*Aspidiotus lataniae* Sign. (fig. 1*C*)
- Circumgenital pores not present.....*Aspidiotus camelliae* Sign. (fig. 1*E*)
- D. Circumgenital pores numerous, always more than seven on each side of pygidium.....*Aspidiotus hederae* (Vallot) (fig. 1*D*)
- Circumgenital pores few in number, never more than seven on each side of pygidium.....*Chrysomphalus dictyospermi* (Morg.) (fig. 1*A*)

⁴ The pygidium is the posterior end of a diaspid scale. It is a fusion of the last five or six of the ten abdominal segments normally characteristic of an insect.

⁵ The insect removed from beneath the wax covering need only be placed on a slide in water, alcohol, or xylol (the latter preferred) and covered with a cover slide. Such a temporary mount is sufficient to permit the determination of the species.

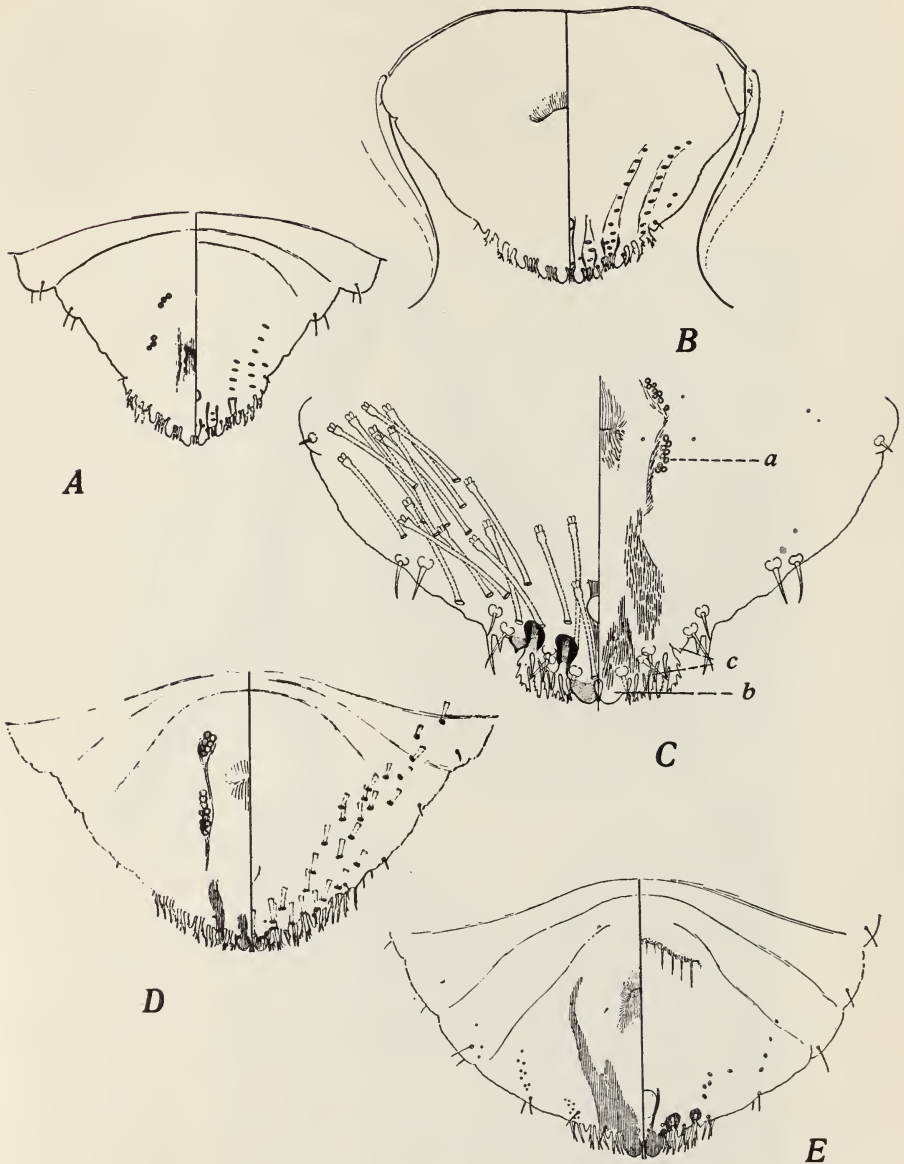


Fig. 1.—A, Pygidium of dictyospermum scale, *Chrysomphalus dictyospermi* (Morg.); B, pygidium of red scale, *Aonidiella aurantii* (Mask.); C, pygidium of lantania scale, *Aspidiotus lantaniae* Sign., showing circumgenital pores (a), median lobes (b), and outer pairs of lobes on pygidium (c); D, pygidium of ivy or oleander scale, *Aspidiotus hederae* (Vallot); E, pygidium of the greedy scale, *Aspidiotus camelliae* Sign. (Drawings A, B, D, and E after Dietz and Morrison.)

LATANIA SCALE

Latania scale, *Aspidiotus lataniae* Sign., is probably the most important insect pest of the avocado in California. It has increased rapidly in the last few years and has caused damage in many groves. The scale is usually most abundant on the branches and twigs, but as the infestation increases, may also be found on the leaves and fruit. The smaller

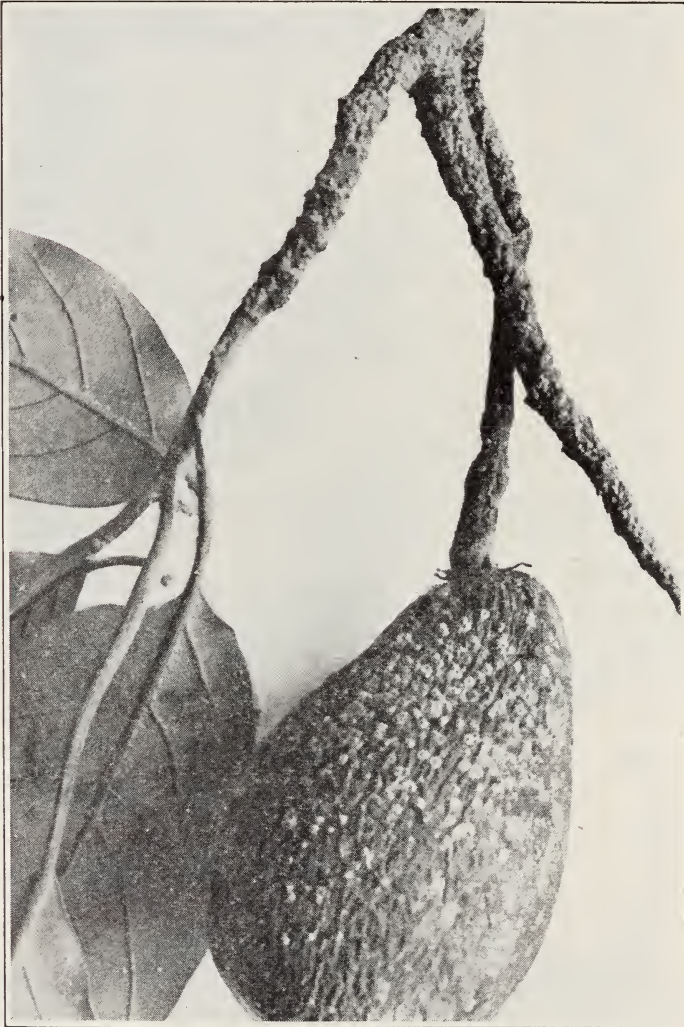


Fig. 2.—The latania scale, *Aspidiotus lataniae* Sign., on avocado fruit, twigs, and leaves. (Courtesy of A. F. Kirkpatrick.)

branches may be killed by a heavy infestation. The marketing quality of the fruit is impaired because of the presence of the scale on the rind (fig. 2). As the fruits mature the insects cause protuberances to extend from the rind down into the flesh, and when the rind is removed, corresponding depressions are left in the flesh (fig. 3).

History and Synonymy.—The latania scale, *Aspidiotus lataniae* Sign., was described by Signoret (1869)⁶ from a palm, *Latania barbonica*, in a



Fig. 3.—Effects of latania scale on the fruit of avocado. Note the depressions caused by the insects. (Courtesy D. B. Mackie, California State Department of Agriculture.)

French conservatory. Apparently the scale was of foreign origin and its mode of entry into the conservatory is not known.

Aspidiotus lataniae Sign. seems to have been defined by well-distinguished characters, since it has stood these sixty or more years. The main confusion has been with *A. cydoniae*, a species since declared a synonym.

Distribution and Hosts.—Mackie (1931) reported the latania scale as being rather generally present in California on avocados in San Diego, Orange, and Los Angeles counties, with only a few light infestations

⁶ See "Bibliography," p. 44, for complete data on citations, which are referred to in the text by author and date of publication.

found in Ventura County. He also gave statistics regarding the prevalence of the scale in each county during 1929 and 1930. Mackie also included a list of the host plants of the world on which the insect has been taken. This list includes some 163 host species and will be omitted from this bulletin. With regard to host plants, latania scale in southern California has not as yet become widespread. Aside from the avocado, which appears to be its primary host, this scale has been found only on canna

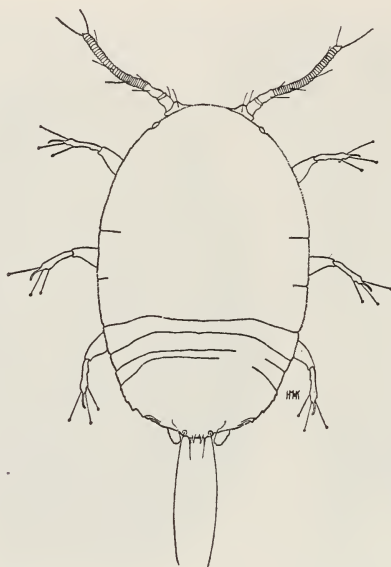


Fig. 4.—The larva or crawler of latania scale. (Greatly enlarged.)

lilies, gladiolus corms, *Grevillea thelemanniana*, raspberries, roses, and *Tamarix* sp. However, an extensive survey of host plants has not been made.

The insect is known to occur in Algeria, Australia, Belgium, Central America, Channel Islands, China, Egypt, Galapagos Islands, Guam, Guatemala, Germany, Hawaii, India, Mauritius, Mexico, Philippine Islands, Rhodesia, South Africa, South America, Syria, Tahiti, and the United States.

Life History.—The yellow eggs of latania scale hatch within a few hours after they have been laid. The first-stage larva, or crawler (fig. 4), of the latania scale is sulfur yellow and measures about 0.1 inch in length. There are four distinct segments to the antennae. The last segment possesses six spines, four of which arise from the sides and two at

the extreme tip. Each tarsus has a single claw, and attached to the tibia are three knobbed hairs that extend beyond the tip of the claw.

The larvae do not, as a general rule, migrate far from the parent insect. They usually settle within 8 hours and start to secrete wax, which eventually becomes the scale covering. The only noticeable external change that takes place after settling is the gradual expansion of the insect and its wax covering.



Fig. 5.—The common chalcid, *Aphytis diaspidis* (Howard), the only hymenopterous parasite that has been recovered from latania scale in California. (Drawing by H. Compere.)

In 14 to 16 days after hatching, the insect molts. The difference in appearance after the first molt is a clear-cut outer rim or margin of the wax covering. The molting process requires from 2 to 3 days. The characters of the pygidium of the second-stage female are quite distinct and are apparently the same as those of the adult female except that they are considerably smaller.

The second molt takes place in from 16 to 19 days after the first molt. Upon completion of this molt the insect enters the adult stage. The pygidium is characterized by one pair of conspicuous, well-developed median lobes, notched externally; thus the distal half is slightly narrower than the basal half. Circumgenital pores are also evident. A drawing of the pygidium of the latania scale (see fig. 1C) will aid in determining this insect. In the adult female the ventral skins of the previous stages may be found closely pressed on the surface of the leaf, twig, or fruit beneath the insect. Crawlers appear within 26 to 30 days after the

second molt. The total length of the life cycle of this insect from egg to adult is approximately two months (56 to 65 days) in summer at Encinitas, California.

Female scales, isolated from birth beneath gelatin capsules, produced young after two months. On the basis of this experiment, and because no male specimens have been found, it is believed that the insect normally reproduces parthenogenetically; that is, reproduction takes place without fertilization.

Birds, insects, and man are responsible to some extent for the dispersion of this insect. Wind may also carry the individual crawler, or a leaf bearing a colony of them, some distance.

Parasites and Predators.—The common chalcid, *Aphytis diaspidis* (Howard) is the only hymenopterous parasite that is known to attack the latania scale in California (fig. 5). It is small, less than 0.1 inch in length, and yellowish. The eggs are a pale yellowish white, with a short stalk at one end. The larvae are white, pear-shaped, and taper toward the posterior end. The larvae feed on the body of the host.

The two-stabbed ladybird beetle, *Chilocorus bivulnerus* Muls., feeds on latania scale. It measures from $\frac{1}{6}$ to $\frac{1}{5}$ inch in length, is nearly hemispherical, shining black, and has two red spots on the elytra. The eggs are orange. The larvae are black and are covered with long branched spines. When full-grown they measure about $\frac{1}{4}$ inch in length. They are also predacious upon the scale insects.

Blaisdell's ladybird, *Lindorus lophanthæ* (Blaisdell) is approximately $\frac{1}{12}$ inch long. The elytra are shining black, and the reddish brown pronotum is frequently marked with a black blotch.

The blood-red ladybird, *Cycloneda rubripennis* Csy., is approximately $\frac{1}{4}$ inch long. The elytra are bright scarlet with a short, transverse basal, paler spot at each side of the scutellum, which is usually black.

Control.—In June, 1931, several tolerance tests with fumigation were made on seedling avocados on the Citrus Experiment Station grounds. Some of the tender growth was burned with the higher dosages, but the injury was not serious. Further tests were made later in the same planting to determine what effect seasonal changes would have on fumigation results. There were no scales on the trees on the Experiment Station property, so counts could not be made. However, in September of the same year, tests were made at Encinitas, California, which indicated that fumigation gave a satisfactory kill of latania scale at all dosages used (18 to 24 cc; see page 13 for explanation of dosage). With the exception of the highest dosage (24 cc) no tree damage occurred.

Fumigation tests, with both liquid cyanide and powdered calcium cyanide, were conducted during August and September, 1931, by D. F. Palmer, Agricultural Inspector at Carlsbad, and A. F. Kirkpatrick.

Tests made in 1932-33 with several different oil sprays gave little



Fig. 6.—A 60-foot light-weight fumigation tent made from 350 sheeting. It will be noted that the avocado tree requires at least a 50-foot tent to cover it. One may hoist a tent over a much larger tree by means of the 30-foot pole shown at the left.

promise of effectively controlling the latania scale on avocado, and at the same time a considerable amount of tree defoliation occurred, as well as a possible inhibition of the set of fruit. A highly refined medium oil (grade 4) applied at 2 per cent strength is as heavy as may be used with reasonable safety and at the same time secure a fair degree of kill on the scale.

As compared with citrus-tree fumigation, which is a very old procedure, a number of new factors are involved in the fumigation of avocado trees. One of these factors is the size of the avocado plantings, many being but from one to five acres in extent. Still another factor is

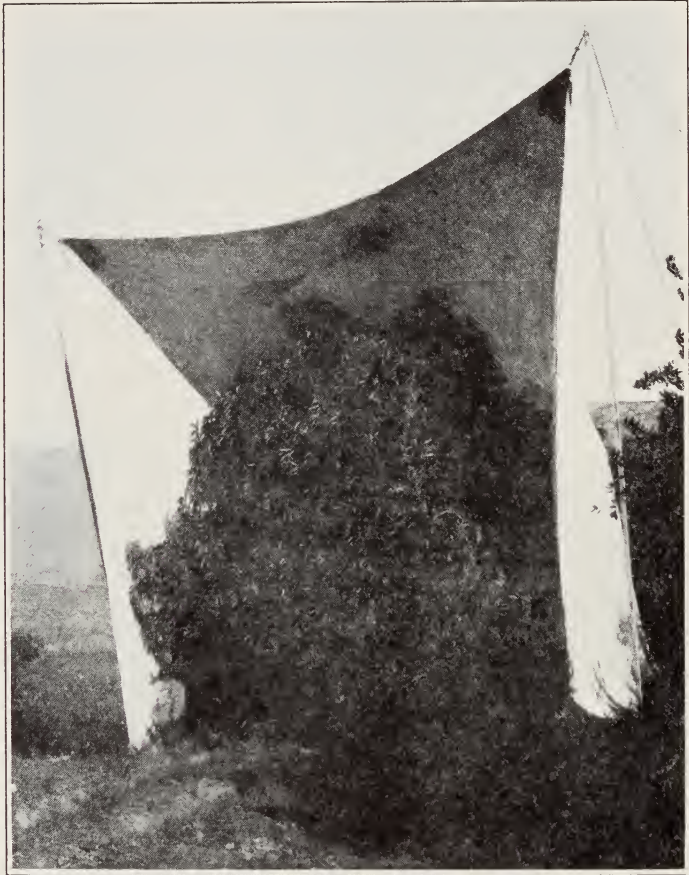


Fig. 7.—Hoisting a fumigation tent over an avocado tree by means of specially constructed 30-foot poles with pulleys and guy ropes attached at the top end.

the greater danger of breaking the avocado branches as the tents are pulled over them. This danger is obviated in part by the use of a light-weight tent, made from 350 sheeting (fig. 6).⁷ For the grower who has only a few acres of avocados, one or more tents may be purchased, and with the coöperation of a neighbor the tents may be hoisted over the

⁷ The term "350 sheeting" means that $3\frac{1}{2}$ yards of material 36 inches wide weighs 1 pound, or 4.57 ounces per square yard.

avocado trees by means of bamboo poles or with specially constructed derricks (fig. 7). By this method, a few trees may be fumigated each night. For such small plantings powdered calcium cyanide may be used, with no particular hazard in connection with the handling of it and with no special apparatus necessary for its use.

The fumigation dosage for a particular tree is measured by means of cups of different sizes, ranging from 1 ounce to 5 or 6 ounces. The amount of calcium cyanide, computed by the measurement of each tree, may be determined by the use of a fumigation chart (table 1). For avocado trees, the dosage used is 2 ounces of calcium cyanide for each of the units called for in the regular citrus-tree schedule (table 1, figures on right side of columns). For example, a tree measuring 44 feet around (figures at top of columns) and 34 feet over (figures at left side of columns) calls for a dosage of 14 units (figures at right side of columns). For dust cyanide, 14 units doubled (28 ounces) will give the number of ounces for the size of tree indicated. When the liquid HCN is used, the applicator should be set for 18 cc; hence the dosage will be $18 \text{ cc} \times 14$, or 252 cc of liquid HCN. The exposure is 45 minutes. When powdered cyanide is used, it is placed in a tin can (a 5-pound Cyanogas can is often used) with a perforated bottom and with a long handle attached for shaking the material on the ground under the tree.

Figures for calculating the *distance over* the tree are marked on the fumigation tent, zero being at the top. When the tent has been thrown over the tree, the figures nearest the ground, on each side of the tree, should be added together. The *distance around* the tree may be measured by a tape.

Fumigation should not be carried on when the wind is blowing sufficiently to move the tents, or when the foliage or ground is wet, or in the warm, bright sunlight. Fumigation is most effective during the months of July, August, September, and October.

For larger plantings fumigation with liquid HCN is recommended because of the larger number of tents required and the consequent greater overhead cost against a single planting. In such work, where thirty or more tents are employed, the use of liquid HCN is preferable to the powdered calcium cyanide, because of the more rapid charging of the tree by the liquid and the lower cost of the material. Experiments in 1934 with liquid HCN under the light-weight tents used in avocado fumigation have proved effective in controlling the latania scale providing the 18 cc schedule is used.

Further details regarding the liquid HCN method of fumigation are not given here because the use of that method is largely restricted to con-

TABLE 1
UNITS OF LIQUID HYDROCYANIC ACID (HCN) REQUIRED TO FUMIGATE AVOCADO TREES
OF DIFFERENT SIZES WHEN 350 SHEETING IS USED FOR TENTING MATERIAL*

12†	14	16	18	20	22	24	26	28	30	32	34
10-2	10-2	10-3	10-3	10-3	12-4	12-4	14-5	16-5	16-5	18-6	18-6
12-3	12-3	12-3	12-4	12-4	14-4	14-5	16-5	18-6	18-6	20-6	20-7
14-3	14-3	14-4	14-4	14-4	16-5	16-5	18-5	20-6	20-6	22-7	22-7
16-4	16-4	16-4	16-4	16-5	18-5	18-5	20-6	22-6	22-7	24-7	24-7
18-4	18-4	18-4	18-5	18-5	20-5	20-6	22-6	24-7	24-7	26-7	26-8
				20-5	22-6	22-6	24-6	26-7	26-7	28-8	28-8
				22-5	24-6	24-6	26-7	28-7	28-7	30-8	30-9
				24-6					30-8	32-9	32-10
											34-10
											36-11
36	38	40	42	44	46	48	50	52	54	56	
18-6	20-7	20-7	20-7	22-8	22-8	26-10	26-11	30-13	30-14	30-14	30-14
20-7	22-7	22-7	22-7	24-9	24-9	28-11	28-12	32-15	32-15	32-15	32-15
22-7	24-8	24-8	24-8	26-10	26-10	30-12	30-13	34-16	34-17	34-17	34-17
24-8	26-9	26-9	26-9	28-11	28-11	32-14	32-14	36-17	36-18	36-18	36-18
26-8	28-9	28-10	28-10	30-12	30-12	34-15	34-15	38-18	38-19	38-20	38-20
28-9	30-10	30-11	30-11	32-13	32-13	36-16	36-17	40-20	40-21	40-21	40-21
30-10	32-11	32-12	32-12	34-14	34-14	38-17	38-18	42-21	42-22	42-23	42-23
32-10	34-12	34-13	34-13	36-15	36-15	40-18	40-19	44-23	44-23	44-24	44-24
34-11	36-13	36-14	36-14	38-16	38-17	42-20	42-21	46-24	46-25	46-26	46-26
36-12	38-14	38-14	38-15	40-17	40-18	44-21	44-22	48-25	48-26	48-27	48-27
38-13		40-16	42-8	42-8	42-19	46-23	46-23	50-26	50-27	50-28	50-28
					44-20	48-24	48-24	50-25		52-30	52-30
58	60	62	64	66	68	70	72	74	76	78	
30-14	32-16	34-18	34-18	36-21	40-25	40-25	42-28	44-30	46-33	48-36	48-36
32-16	34-18	36-20	36-20	38-22	42-26	42-27	44-30	46-32	48-35	50-38	50-38
34-17	36-19	38-21	38-22	40-24	44-28	44-29	46-32	48-34	50-37	52-40	52-40
36-19	38-21	40-23	40-24	42-26	46-30	46-31	48-34	50-36	52-39	54-42	54-42
38-20	40-22	42-25	42-25	44-28	48-32	48-33	50-36	52-38	54-41	56-44	56-44
40-22	42-24	44-27	44-27	46-29	50-34	50-35	52-38	54-40	56-43	58-47	58-47
42-23	44-26	46-28	46-29	48-31	52-36	52-37	54-40	56-42	58-45		
44-25	46-27	48-30	48-31	50-33	54-38	54-39	56-42	58-43			
46-27	48-29	50-31	50-32	52-35	56-40	56-41					
48-28	50-30	52-33	52-34	54-37	58-41	58-42					
50-30	52-32	54-35	54-36	56-39							
52-31	54-33	56-36	56-38	58-40							
54-32	56-35	58-38	58-39								
	58-36										
80	82	84	86	88							
50-38	52-41	54-44	56-50	58-54							
52-40	54-43	56-47	58-53	60-56							
54-42	56-45	58-50	60-55	62-58							
56-44	58-48	60-55	62-57	64-60							
58-47	60-53	62-57	64-60	66-65							
60-50	62-55	64-59	66-64	68-70							
62-53	64-57	66-60	68-66								
64-55	66-59	68-64									
66-57	68-60										
68-59											

* Adapted from: Quayle, H. J. Biology and control of citrus insects and mites. California Agr. Exp. Sta. Bul. 542:74 (table 1). 1932.

† Figures across top of columns represent *distance around* in feet, those on left side of columns *distance over* in feet. *Italic figures on right side of columns represent dosage in units of HCN.* When calcium cyanide is used, the figures on the right side of columns, when doubled, give the number of ounces required.

tractors and others especially equipped for fumigation work on a large scale.⁸

Perhaps the parts of the avocado tree most susceptible to fumigation injury are the blossoms and young fruit. The tender growth may burn but new growth rapidly appears and the tree soon recovers. In the case of blossoms and young fruit, however, such is not the case. Much remains to be learned about the fumigation of avocado trees, and this subject is still under investigation by the Citrus Experiment Station.

DICTYOSPERMUM SCALE

The dictyospermum scale, *Chrysomphalus dictyospermi* (Morgan), has been found in California in the avocado-growing areas at Whittier. To date it has caused little damage in this region, but eventually it may become an important pest of avocados in the state. In Florida the dictyospermum is the most destructive scale-insect pest of avocados. A drawing of the pygidium of this scale (fig. 1A) will aid in its identification.

The dictyospermum scale attacks primarily the twigs and branches, and as the infestation becomes greater the foliage is attacked. Branches and twigs that have been severely attacked by this scale become roughened, crack, and fail to function properly.

For control see latania scale.

GREEDY SCALE

The greedy scale, *Aspidiotus camelliae* Sign., is frequently found on avocados. It is so similar to the latania scale that growers are usually confused as to its identity. The pygidium of this scale (fig. 1E) may be compared with that of the latania scale.

For control see latania scale.

IVY OR OLEANDER SCALE

The ivy or oleander scale, *Aspidiotus hederae* (Vallot), like the above species, is difficult to separate from the latania scale. The pygidium (fig. 1D) is the only certain means of distinguishing this scale from the latania and greedy scales.

For control see latania scale.

RED SCALE

The red scale, *Aonidiella aurantii* (Mask.), occasionally attacks the avocado, especially where the avocado grove is near a citrus planting.

⁸ Growers wishing further details in regard to the liquid HCN method of fumigation are referred to: Quayle, H. J. Biology and control of citrus insects and mites. California Agr. Exp. Sta. Bul. 542:72-79.

Wherever this scale occurs, it usually increases rather rapidly and control measures are necessary. For identification see pygidium of red scale (fig. 1*B*).

For control see latania scale.

SOFT BROWN SCALE

The soft brown scale, *Coccus hesperidum* (Linn.), (fig. 8) is common in California on avocados, especially along the coast near Encinitas and Carlsbad. This scale produces a considerable amount of honeydew and is responsible for much smutting of the foliage. There are several generations a year.

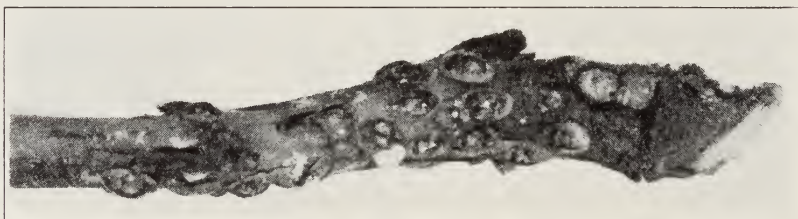


Fig. 8.—Soft brown scale, *Coccus hesperidum* (Linn.), on a twig of avocado.

There are many parasites which control the soft brown scale. Frequently, however, ants are present in large numbers, feeding on the honeydew excreted by the scales. In such cases it is necessary to control the ants in order that the parasites may work undisturbed.⁹

BLACK SCALE

The black scale, *Saissetia oleae* (Bernard), is occasionally found on avocados in California but, with an occasional exception, it is of no particular importance.

Treatment should be made when the insects are all in the younger stages, at which time they are more readily killed. Satisfactory results may be obtained by fumigation or a light-oil spray.

OMNIVOROUS LOOPER

The omnivorous looper, *Sabulodes caberata* Gn., is one of the most important leaf-feeding insects of the avocado. Sometimes these insects become numerous enough to strip the tree of practically its entire foliage.

⁹ Readers desiring further information in regard to Argentine ant control may consult: Quayle, H. J. Biology and control of citrus insects and mites. California Agr. Exp. Sta. Bul. 542:64, 1932.

History and Synonymy.—The omnivorous looper belongs to the order Lepidoptera, family Geometridae (measuring worms). According to the literature to date this insect is native to California. It was originally described by Guenée (1857), who also gave the following synonyms: *Sabulodes aegrotata* Guenée and *S. forficaria* Guenée. Walker (1860) described this moth as *Sabulodes arsenaria*.

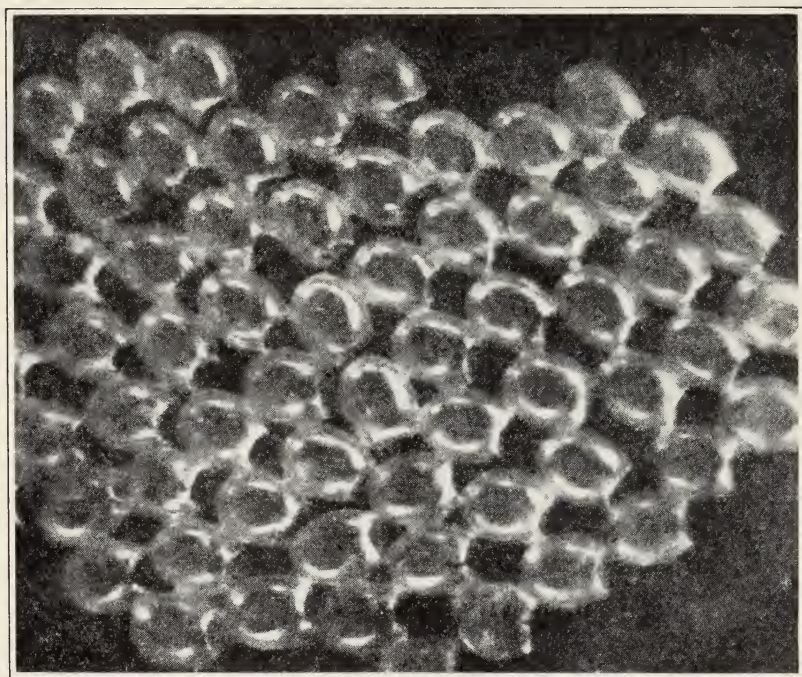


Fig. 9.—Hatched eggs of the omnivorous looper, *Sabulodes caberata* (Gn.), on a leaf of the avocado.

Distribution and Hosts.—The omnivorous looper is distributed generally throughout California but has not been recorded in any of the other western states.

This insect has a large number of host plants, of which the following, listed by Essig (1926), are representative: acacia, alder, aralia, avocado, box elder, buckeye, California laurel, California Christmas berry, cherry, chestnut, clematis, daisy, elm, English ivy, eucalyptus, geranium, ginkgo, grevillea, groundsel, honeysuckle, lemon, lemon verbena, magnolia, maple, olive, orange, passion vine, pecan, pepper tree, rose, sumac, sycamore, tecoma, violet, black walnut, and willow. The present writer has also taken specimens feeding on a species of privet in San Diego County.

Life History.—The eggs of *Sabulodes caberata* Gn. are ovoid in shape, about $\frac{1}{16}$ inch long, and are a little larger at the anterior end (fig. 9). There are several small, round tubercles arranged in a circle around the anterior or large end of the egg. The eggs are deposited in clusters on

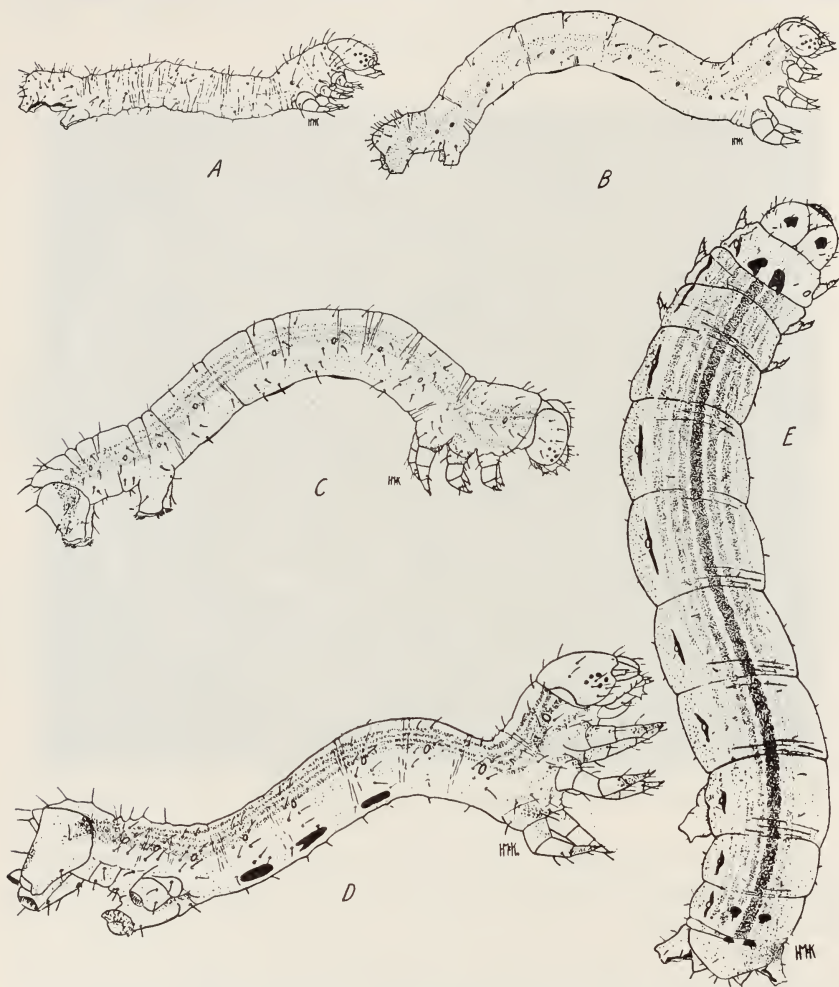


Fig. 10.—The omnivorous looper: A, first-stage larva; B, second-stage larva; C, third-stage larva; D, fourth-stage larva; E, fifth-stage larva.

the undersides of leaves. Each cluster may consist of from 3 to 80 eggs. One side of each egg is laid flat on the leaf. Just after the eggs have been laid they are metallic green, but in two days turn to a chocolate brown. They hatch within 8 or 9 days, according to temperature and humidity.

When the larva emerges from the egg, it is pale yellow and measures

about $\frac{1}{16}$ inch in length (fig. 10A). It is very active and immediately begins feeding on the young, tender growth. Only the epidermis is eaten from the leaf, for until it approaches the first molt the larva is unable to make holes in the leaf. If disturbed while on the tree, the insect drops suddenly, spinning a silken thread from which it may hang suspended in the air for some time. These silken threads may attain lengths of from 1 to 3 feet.



Fig. 11.—Damage caused by the omnivorous looper.

The second-stage larva (fig. 10B) is $\frac{1}{4}$ inch in length and is characterized by two dark bands along the sides of the body.

The third-stage larva (fig. 10C) is $\frac{1}{2}$ inch long and has four dark bands along the sides of the body. These bands fuse toward the posterior end of the body and extend down the hind pair of prolegs.

The fourth-stage larva (fig. 10D) measures a little more than $\frac{3}{4}$ inch in length and is practically identical with the larva of the previous stage except that it has two black dots on the front of the head.

The fifth-stage larva (fig. 10E) measures from 2 to $2\frac{1}{2}$ inches long and about $\frac{1}{4}$ inch wide.

The larvae of the omnivorous looper vary from yellow to pale green or pink, with yellow, brown, or green stripes on the sides and back and with black markings over the body. During the third, fourth, and fifth larval stages, the insect feeds voraciously (fig. 11). One large avocado leaf may easily be consumed in 24 hours by a larva of the fifth stage. The duration of the larval stages of the late summer brood is shown in table 2.

TABLE 2
DURATION OF LARVAL STAGES OF THE OMNIVOROUS LOOPER*

Stage	Minimum, days	Maximum, days	Average, days
First.....	5	11	7.67
Second.....	3	10	5.76
Third.....	4	12	7.35
Fourth.....	4	13	7.65
Fifth.....	9	19	14.80
Total.....	25	65	43.23

* Late summer brood under outdoor conditions existing at Encinitas, California.

The third and fourth-stage larvae become sluggish and commonly spin a web in a leaf fold, or between two or more leaves, in which to rest during the day. As the fifth-stage larva approaches pupation, it shrinks somewhat and turns white (fig. 12, left).

The pupa (fig. 12) is approximately $1\frac{1}{4}$ inches long. It is pearly white but becomes a dark brown as the wings develop. It is usually found webbed between two leaves or inside one leaf which has been pulled together for the purpose. The pupal period lasts from 13 to 33 days, according to climatic conditions.

The adult moth, *Sabulodes caberata* Gn., (fig. 13) is dull brown or yellow and has a wing expanse of from $1\frac{3}{4}$ to 2 inches. Some of the female moths that were caught in the field laid from 200 to 300 eggs. The moths are nocturnal but may be found during the day clinging to the undersides of leaves with their wings spread. If disturbed, however, they fly rapidly in a broken up-and-down movement for several yards; but when they alight they remain motionless. The moths die within two to three weeks after emerging from the cocoons. The total length of the life cycle of this insect from egg to adult is approximately $1\frac{1}{2}$ months in summer at Encinitas. There appear to be from five to six generations a year.

Parasites.—The most important parasite of the omnivorous looper is an insect belonging to the order Hymenoptera, family Braconidae, namely, *Habrobracon xanthonotus* (Ashm.) (fig. 14). The female para-

site stings the caterpillar near the head and as a general rule attacks from the front. This results in paralysis of the caterpillar. The parasite will not, apparently, oviposit on a dead individual. Its eggs are extremely small and are almost invisible to the unaided eye. They are elongate and pearly white. The eggs are laid on various parts of the caterpillar and hatch within 1 or 2 days. The larva is whitish, and the body is



Fig. 12.—Fifth-stage larvae of the omnivorous looper (left); the white individual is approaching pupation. (Original.) Newly formed pupae shown at the right. (Courtesy of C. J. Pierson.)

covered with small protrusions. As it approaches pupation it works its way beneath the decaying caterpillar to pupate. The larval period terminates in 4 to 6 days. The pupae are enclosed in flimsy white cocoons. These cocoons are found in clusters, from 18 to 22 cocoons in each cluster. The pupal period lasts from 8 to 10 days. The adults emerge through round holes at the ends of the cocoons.

This parasite produced at least 70 per cent parasitism of the omnivorous looper in 1932, yet this is not sufficient for control.

Trichogramma minutum Riley is another insect enemy of the omnivorous looper. It is a cosmopolitan parasite on the eggs of many insects. A single specimen of the parasite *Brachymeria ovata* (Say) was recovered from a discolored pupa of the omnivorous looper. One specimen of *Telenomus* was reared from an egg of the omnivorous looper. It is jet black and very small. This insect is a hymenopterous parasite belonging to the family Scelionidae. *Ophion abnormis* var. *magniceps* Hooker, a

hymenopterous parasite belonging to the family Ichneumonidae, attacks the pupae of the omnivorous looper in California and is common in the San Francisco Bay region. It measures from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length and is amber brown with many conspicuous white lines and specks on the head and thorax.

Disease of the Looper.—The omnivorous looper is attacked by a fungus disease similar to the wilt disease of the silkworm. It appears to be an intestinal disease and seems to attack only caterpillars of the third,

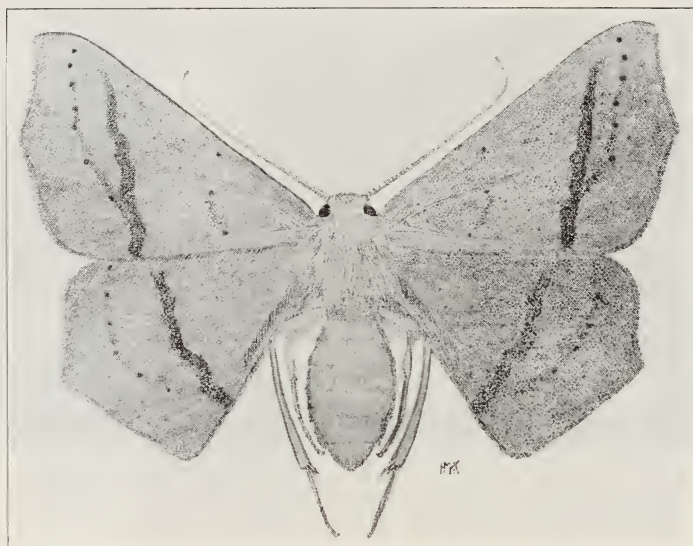


Fig. 13.—Adult female of the omnivorous looper with wings spread.

fourth, and fifth stages (fig. 15). Out of 88 caterpillars used to carry out a certain experiment, only 2 pupated; the remainder were attacked by this organism.

During the latter part of 1932 and 1933, the looper was successfully controlled by the fungus disease. Yet it is well to keep in mind the fact that the principal damage to the trees had occurred before the caterpillars became infected by this disease.

Control.—After several preliminary experiments it was found that the looper moths were attracted to ordinary electric light. Light traps were built with a 50-watt bulb that was hung suspended from a cord a few inches above a galvanized tub filled with water with a thin film of kerosene on the surface. These traps were so designed that when the moth swooped toward the light it would fall into the tub. Tests were

conducted to see what effect these light traps would have on the control of this pest. Since the initial number of moths caught in the light traps was relatively small as compared to the number still left in the field, light-trap experiments were discontinued.

In bait-trap experiments a material called Diamalt was used. This poison bait is made up of the following ingredients:

Diamalt	1 pint
Water	19 pints
Yeast (compressed)	1 cake

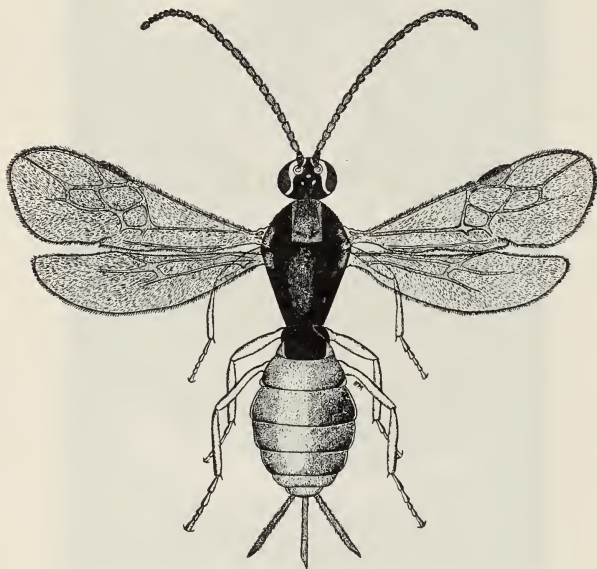


Fig. 14.—*Habrobracon xanthonotus* (Ashm.), a parasite of the looper. Adult female with wings spread.

The Diamalt was first put into water and stirred until dissolved. The yeast was then dissolved in a small amount of water and added to the Diamalt solution. The mixture was poured into twenty-two pans, with wire handles. Each pan was hung over one end of an irrigation standard, some 12 feet above the ground. In one week the pans were examined and only 50 moths were found.

Owing to the fact that the fungus disease cannot be depended upon every year, and to the fact that the parasites and light and bait traps are not effective in controlling the omnivorous looper, mechanical methods must be relied upon. Several tests were made with poison dusts. J. D. Hoffman's avocado grove at Encinitas, California, was first arbitrarily divided into four one-acre plots. In each of these plots, four trees

of different varieties of avocado were chosen. Fumigation tents were then spread under the four trees in each plot and the live caterpillars on each tree counted. The four plots were dusted, one with standard lead arsenate, one with basic lead arsenate, one with cryolite (synthetic), and one with barium fluosilicate. Thirty pounds of each insecticide were

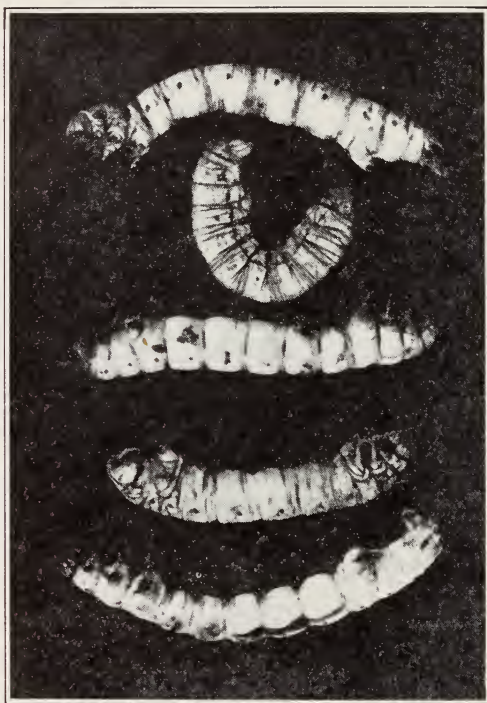


Fig. 15.—Last-stage larvae of the omnivorous looper that have succumbed from the attack of the wilt disease.

mixed with 70 pounds of diatomaceous earth. The remainder of the grove served as a check plot. The caterpillars killed by the poison dusts dropped to the tents spread on the ground below the trees. These dead caterpillars were counted, and the data indicated that comparable results were obtained through the use of basic and standard lead arsenate. Later (1933-34) it was found that standard lead arsenate, applied as a spray, proved more effective than the basic lead arsenate. The spray recommended is as follows:

Standard lead arsenate.....	4 pounds
Blood albumin spreader.....	6 ounces
Water	100 gallons

It is advisable to use 30 per cent of the basic lead arsenate plus 70 per cent diatomaceous earth or sulfur if mites are present, applied when the trees are in blossom and when the fruits are small.

By studying the life history of the insect it was possible to correlate the time of application of the poison with the life stage of the insect that was most susceptible to control measures. In this case the first application was made while the greatest number of individuals were in the first larval stage. The second application should be timed to reach the young caterpillars of the following brood before they have a chance to mature. However, when the standard lead arsenate is applied as a spray, the lasting qualities are much greater. In the case of overhead irrigation, the applications should be made soon after irrigating, because better results are obtained if the insecticide is left on the tree as long as possible.

AMORBIA

Amorbia essigana Busek is a member of the order Lepidoptera, family Tortricidae (leaf rollers). In 1922 the first record of its occurrence in



Fig. 16.—Injury to small avocado fruits by amorbia, *Amorbia essigana* Busek.

California was made by E. O. Essig, who, in a letter to Busek, reported it as doing considerable damage to the foliage in avocado orchards. According to Busek (1929) it is allied to the larger California species, *Amorbia cuneana* Walsingham, and may eventually prove to represent not more than a variety or possibly a subspecies of *cuneana*.

Distribution and Hosts.—According to Busek this species is found in

San Diego and Los Angeles counties, California. The writer has also collected specimens in Orange County. The amorbia seems to prefer only one host plant, the avocado.

Nature of Injury.—The injury caused by the amorbia is important because it is more noticeable on the avocado fruits than on the leaves.

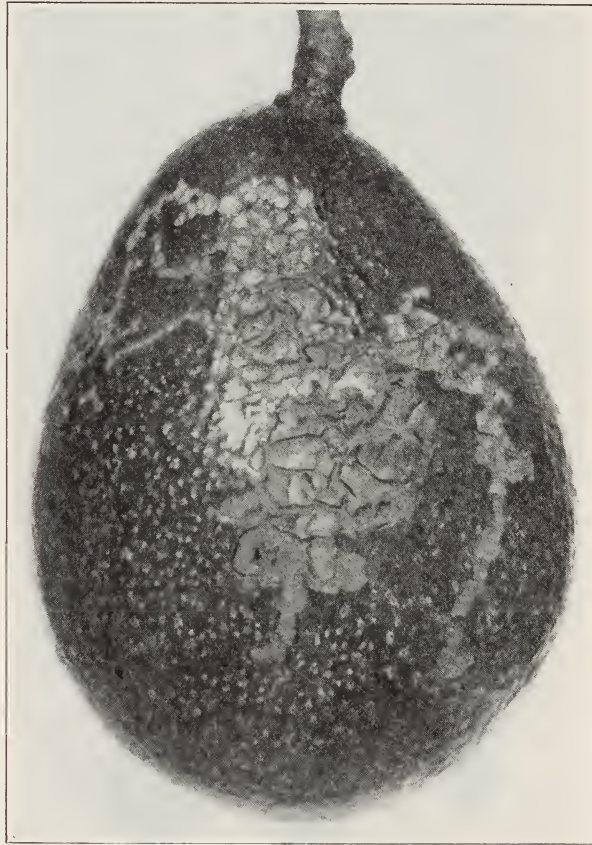


Fig. 17.—A fruit of the Anaheim variety showing ultimate result of amorbia injury.

Young fruits are most frequently attacked and the scarring (fig. 16) enlarges as the fruits mature (fig. 17). This naturally reduces the quality of the fruit and impairs its market value. Injury to the leaves (fig. 18) may become of considerable importance and yet it is slight compared to that of the omnivorous looper. Injury to the leaves consists primarily in a skeletonizing effect.

Life History.—The eggs (fig. 19) of the amorbia are usually de-

posited on the top side of the leaf along the midrib. They are greenish and laid in flat masses that may consist of from 5 to 98 eggs. A single moth may lay from 400 to 500 eggs. The incubation period varies from 13 to 15 days.



Fig. 18.—Characteristic webbing and leaf injury of amorbia on the avocado.

There are seven larval stages of this insect. Pupation may occur, however, after the fifth or sixth stages as well as after the seventh. The first-stage caterpillar is small and yellowish green. The larvae of the second, third, fourth, fifth, and sixth stages are somewhat alike except for size. The seventh-stage larva (fig. 20) measures from $\frac{3}{4}$ inch to $1\frac{1}{8}$ inches in length. Considerable damage is done to the fruits touching one another, because the larvae will web between the fruits and eat the

epidermis of the avocado. More larvae mature on the foliage, however, than on the fruits. Even before the first molt the young larvae usually web two leaves together, and in these chambers they remain hidden

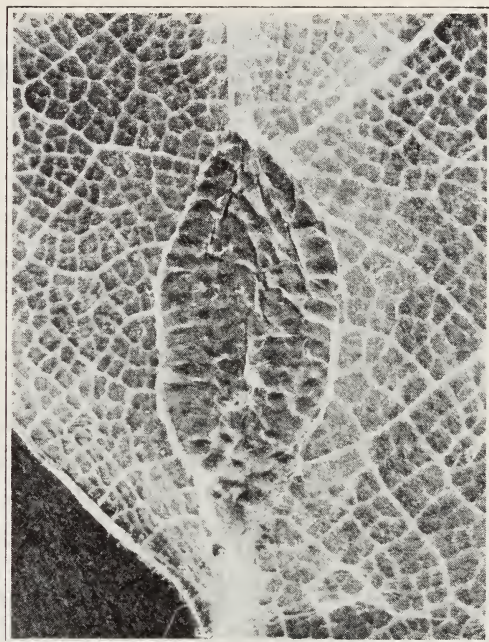


Fig. 19.—Greenish egg mass of amorbia. (Greatly enlarged.)

during the daytime. If the leaves are pulled apart the larvae will wriggle violently and fall to the ground. The length of the larval stages of the late summer brood is given in table 3.

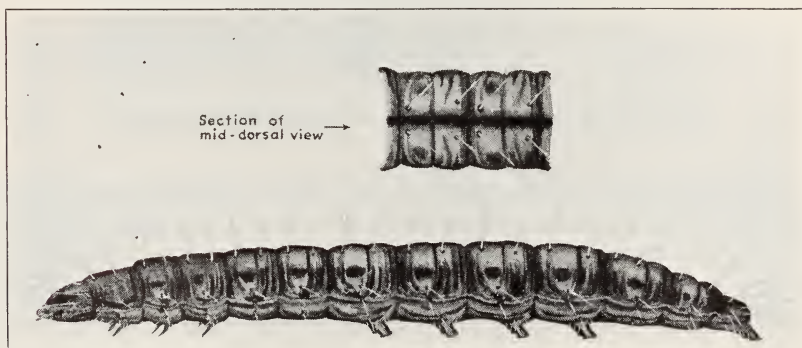


Fig. 20.—Last-stage larva of amorbia. (Drawing by C. M. Dammers; greatly enlarged.)

The pupa (fig. 21) is from $\frac{1}{2}$ to almost $\frac{3}{4}$ inch in length. The newly formed pupa is pale green, but as the wings develop it becomes more and more pigmented until finally it turns chocolate brown. The pupae are



Fig. 21.—Cast pupal skin of amorbia on avocado leaf. (Slightly enlarged.)

usually found between two leaves webbed together for that purpose. The pupal stage lasts from 11 to 21 days, with an average of 17 days.

The adult moth of the amorbia has reddish-brown (chocolate) forewings (fig. 22). It has a wing expanse of about one inch. The moths are seldom seen during the day unless disturbed from their resting places on the undersides of leaves. The total length of the life cycle of this insect from egg to adult is approximately two months in summer at Enci-

TABLE 3
DURATION OF LARVAL STAGES OF AMORBIA*

Stage	Minimum, days	Maximum, days	Average, days
First.....	7	21	13.32
Second.....	3	11	6.70
Third.....	3	14	6.29
Fourth.....	3	11	6.05
Fifth.....	4	19	8.05
Sixth.....	4	16	10.31
Seventh.....	7	20	12.87
Total.....	31	112	63.59

* Late summer brood under outdoor conditions existing at Encinitas, California.

nitae. There appear to be four or five generations a year, but further study will be needed to verify this fact.

Parasites.—One parasite was found attacking the amorbia. It is an egg parasite, *Trichogramma minutum* Riley, also parasitic on the omnivorous looper. It is not effective in controlling the amorbia.

Control.—A light-trap experiment used with the omnivorous looper was again conducted to see what effect ordinary electric light would

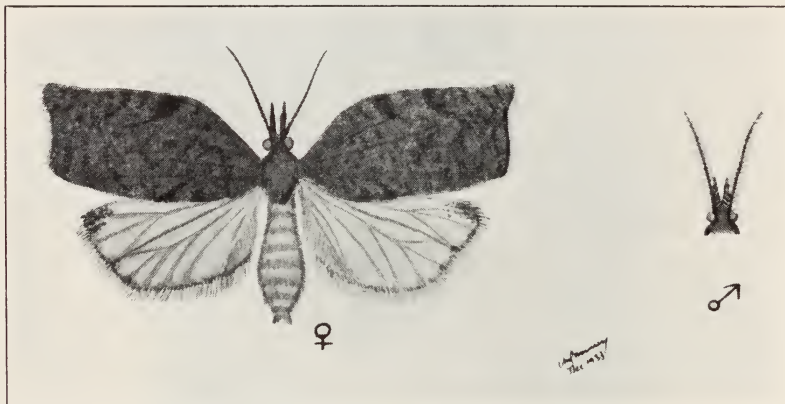


Fig. 22.—Adult female of the amorbia moth. (Drawing by C. M. Dammers.)

have on the amorbia. The preliminary data indicate that light traps are not effective in controlling this moth.

Like the light traps, bait traps used for the omnivorous looper appeared to be ineffective in controlling the amorbia. With the use of Diamond bait, only 17 moths were captured in one week.

The control of this insect is the same as for the omnivorous looper. However, since there appears to be a considerable overlapping of generations, several applications of standard lead arsenate spray are necessary in order to keep the amorbia in check. Applications should be made at one-month intervals.

JUNE BEETLES

Occasionally outbreaks of two species of June beetles (Coleoptera, Scarabaeidae), *Serica fimbriata* Lec. (fig. 23) and *S. alternata* Lec., are observed on young avocado trees. They are medium-sized, somewhat cylindrical, robust, usually smooth or velvety brown, with faintly striated elytra. *Serica fimbriata* is the larger of the two beetles, measuring approximately $\frac{1}{2}$ inch in length. *Serica alternata* is $\frac{3}{8}$ inch long and of uniform shiny brown color.

Life History.—The larvae or grubs of these June beetles are usually

thick, wrinkled, white or yellow, somewhat hairy, enlarged posteriorly and usually in the form of a crescent, with well-developed legs.

The adults are nocturnal and the larvae feed underground on decayed and living vegetation. As a general rule, these beetles are most abundant wherever there is native vegetation near a cultivated avocado grove.

Control.—A spray of standard lead arsenate, used at the rate of 4 pounds to 100 gallons of water plus 6 ounces of blood albumin spreader, is only fairly satisfactory in controlling the *Serica* beetles. If the trees are in bloom, application of a dust of 30 pounds of basic lead arsenate plus 70 pounds of diatomaceous earth is recommended.

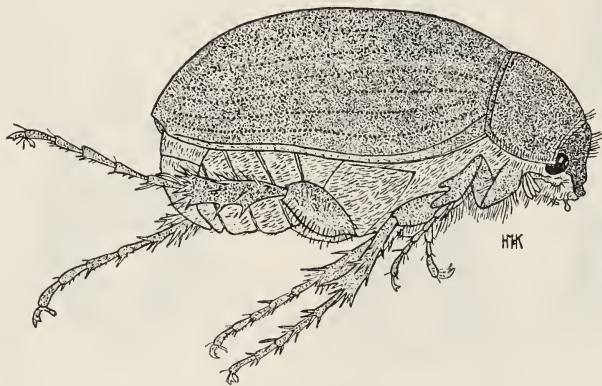


Fig. 23.—June beetle, *Serica fimbriata* Lec.

FULLER'S ROSE WEEVIL

Fuller's rose weevil *Pantomorus godmani* (Crotch), measures approximately $\frac{3}{8}$ inch in length and is a uniform pale brown. The eggs of this weevil are elliptical, pale yellow, and smooth; they measure about $\frac{1}{25}$ inch in length. In the spring of the year, the eggs are laid in irregular rows in masses, either on the ground near the host, under the bark of trees, or near the bases of smaller plants. The legless white larvae or grubs are about $\frac{1}{5}$ inch long and live on the roots of plants. Pupation takes place in a cell in the ground.

One very serious infestation of this weevil was observed in 1933 at Encinitas on young avocado trees.

Since the adults cannot fly it is possible to prevent them from ascending the avocado trees by a tanglefoot band,¹⁰ provided that the branches of the tree do not touch the ground. Where bands are not used, see control for the omnivorous looper.

¹⁰ Paraffin should be placed around the trunk of the avocado tree to prevent injury to the bark caused by the tanglefoot. After the paraffin has hardened sufficiently, the tanglefoot band may be placed around the trunk over the paraffin.

Cryolite apparently kills the fuller's rose weevil more effectively than standard lead arsenate, but the injury it causes to the avocado tree along the coast renders it unsafe to use.

BROWN MITE

The avocado brown mite, *Paratetranychus yothersi* McG., is a pest of the avocado and in many instances causes serious damage to the trees. Since these mites are almost invisible to the unaided eye, and because the foliage does not show injury until the mites become abundant, the

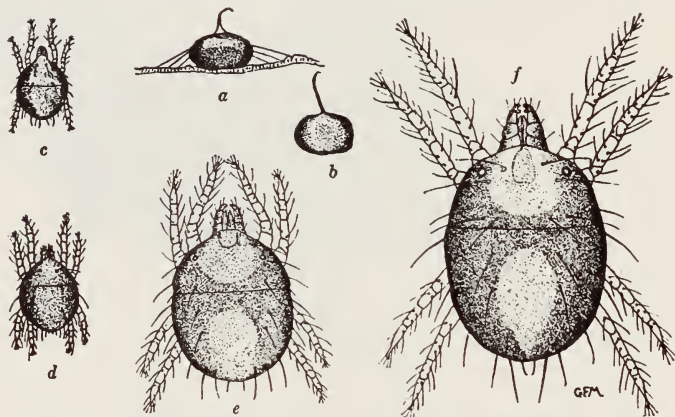


Fig. 24.—The avocado brown mite, *Paratetranychus yothersi* McG: a, b, egg; c, larva; d, first nymph; e, second nymph; f, adult female. (Courtesy United States Department of Agriculture.)

actual injury done is usually underestimated. If climatic conditions are not favorable for the mites the injury is not important and in such cases treatment is unnecessary. If the mites become abundant, however, control measures should be resorted to immediately.

Distribution and Hosts.—The avocado brown mite belongs to the order Acarina, family Tetranychidae. It was first described from specimens taken from the upper surface of camphor leaves, *Camphora officinale*, in Florida. It has been recorded as feeding on the following plants: eucalyptus, elm, willow, oak, and pecan. In California the writer has collected specimens in San Diego, Orange, and Los Angeles counties.

Nature of Injury.—The avocado brown mite confines its feeding entirely to the top surface of the leaf. The first evidences of brown mite work are the pale white spots that are scattered over the green leaf surface. These represent the feeding places of the mites and are caused by the actual removal of the green matter or chlorophyll from the leaf. As the mites become more and more numerous, practically all of the green

matter is removed, leaving the leaf entirely brown. Restoration from this type of injury is rapid if the mites are destroyed before the leaves are too seriously injured. However, such injured leaves fall prematurely, causing in some cases a heavy defoliation.

Life History.—The egg of this mite (fig. 24, *a* and *b*) is a flattened sphere with a prominent stalk. In height, this stalk is about twice the diameter of the egg. Small threads seem to support the egg around the base. Just after the egg has been laid it is pale yellow, but within a day turns to a dark reddish brown. The average number of eggs laid by a single female mite is about 35. The incubation period varies from 7 to 10 days, according to climatic conditions.

When the egg hatches it splits into halves in an even line around the equatorial zone. After the larva works its way out of the egg the two halves of the eggshell spring back into place again. The larva (fig. 24*c*) is pale yellow and has but three pairs of legs, the fourth pair being acquired after the first molt. Almost immediately after hatching the larva begins to feed, sucking the coloring from the leaf. The larval stage lasts from 2 to 3 days.

The first-stage nymph (fig. 24*d*) is similar to the larva except that it is somewhat larger and possesses an additional pair of legs, and the body is darker. This stage lasts from 2 to 3 days, during which time another molt occurs.

The second-stage nymph (fig. 24*e*) is almost identical with the first-stage nymph except that it is somewhat larger and of a darker reddish brown. This stage lasts from 2 to 3 days, when the nymph molts and becomes the adult mite.

The adult of the avocado brown mite (fig. 24*f*) is a rusty red or chocolate color. The body of the female mite is robust and oval, while the male is narrower and pointed posteriorly. The total length of the life cycle of this insect from egg to adult is approximately one-half month in summer at Encinitas. There are many generations produced in one season.

Dispersal.—The brown mites are very active and are capable of traveling considerable distances through their own powers of locomotion. As a general rule, however, they remain throughout their life on the same leaf or closely adjoining ones. Mites are occasionally observed on the ground, but they do not breed there. Leaves bearing colonies of mites frequently fall or are blown to the ground by the wind. Perhaps the greatest factor in the dispersion of the avocado brown mite is wind, either carrying the individual mite or a leaf bearing a colony of them. Birds, insects, and man are also undoubtedly responsible for the dispersion of small numbers of mites.

Predators.—The avocado brown mite, exposed as it is on the upper surface of the leaves, is subject to the attacks of several enemies. Those enemies are the same as attack the citrus red spider.¹¹

Control.—Sulfur, applied at full strength, is satisfactory in controlling the brown mite on avocado. Since the leaf is free from excessive webbing in the case of the avocado brown mite, the sulfur may be brought into intimate contact with the mites. Along the coastal areas, where the mite is most abundant, one or two applications, sometimes followed by a spotted application, are usually effective in controlling the mites. The sulfur should be applied when there is little wind.



Fig. 25.—Adult greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché). (After Russell, United States Department of Agriculture.)

GREENHOUSE THRIPS

The greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché), is a pest in many parts of the United States. It also occurs in Europe, Asia, and the South Sea Islands. In western North America, it is most often found outdoors on ornamental trees and shrubs. It is omnivorous in its feeding habits.

Description.—The greenhouse thrips (fig. 25) may be characterized by the reticulated surface, very dark brown to almost black, and eight-jointed antennae.

Nature of Injury.—Injury is caused to both the fruit and the leaves of the avocado. Injury to the leaves consists of rasping and puncturing

¹¹ For an account of predators on the citrus red spider, consult: Quayle, H. J., Biology and control of citrus insects and mites. California Agr. Exp. Sta. Bul. 542:10–13.

minute areas of the surface or epidermis and sucking out the chlorophyll, which results in a bleached appearance. Large areas, sometimes covering practically the entire leaf (fig. 26), may take on a silvery or bleached appearance in the case of a severe infestation. This injury subsequently results in the drying up and falling of the leaves. Injury to the fruit is



Fig. 26.—Typical avocado-leaf injury as caused by the greenhouse thrips.

caused by the insects rasping off the surface of the skin. A green fruit that has been seriously attacked by this thrips will ultimately acquire a brownish appearance as a result of the extraction of chlorophyll. As a result of this injury the affected areas become russety and deep cracks may develop as the fruit increases in size.

Control.—A highly refined light medium oil, of a viscosity of 70 seconds, may be used at $1\frac{1}{2}$ per cent with 1 pint of nicotine sulfate plus 1 pound of casein spreader to 100 gallons of diluted spray. Two applications may be necessary, with an interval of 2 or 3 weeks.

BROAD-NOSED GRAIN WEEVIL

The broad-nosed grain weevil, *Caulophilus latinasus* Say, was first recorded in California in October, 1927, by A. A. Brock, at that time

Agricultural Commissioner of Orange County. Since then it has spread rather generally throughout the state.

Distribution and Hosts.—According to the literature, this species is limited in its distribution and it is unlikely that it is cosmopolitan. It has been recorded from the West Indies, Georgia, South Carolina, Jamaica,

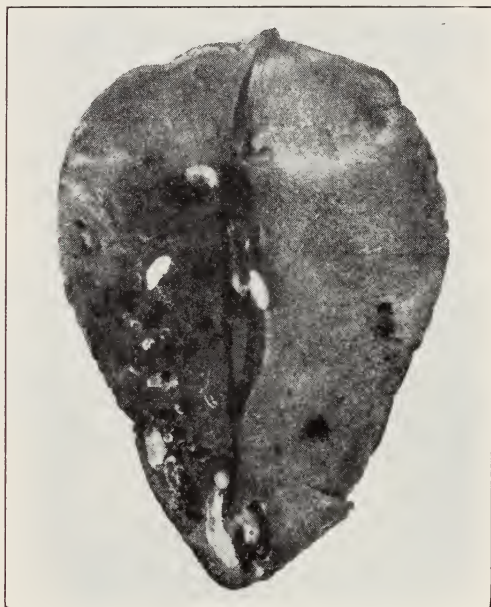


Fig. 27.—Larvae and pupae of the broad-nosed grain weevil, *Caulophilus latinasus* Say, in the seed of an avocado. Note holes made by the larvae. (Slightly enlarged.)

Puerto Rico, Mexico, Guatemala, and Madeira. Avocado seeds are apparently the primary host of this species in California. Other known hosts are chickpeas, Indian corn, and ginger.

Description and Habits.—Superficially this species resembles the granary weevil, *Sitophilus granarius* (Linn.) (*Calandra granaria* Linn.), except that it is a darker brown. It belongs to the same family, Calandridae of the Rhynchophora.

The attacks of the broad-nosed grain weevil on avocado may be considered of secondary importance. It attacks fallen fruits, boring through the rotting flesh and entering the seed (fig. 27). No fruit, while on the tree, has as yet been found attacked by this species.

FALSE CHINCH BUG

The false chinch bug, *Nysius ericae* (Schilling), is a light or dark-gray species, measuring approximately $\frac{1}{8}$ inch in length. The nymph is pale gray with reddish-brown abdomen, resembling the dry weeds and soil to a remarkable degree. This species breeds and feeds primarily in the native grasslands. In September and October, and again in May and June, the wingless nymphs swarm from the dry grasslands into adjoining avocado groves and infest primarily the smaller trees, causing considerable damage. After the spring swarming, maturity is reached and eggs are laid in cracks in the soil or on grass and weeds. There are from four to seven generations a year. The winter may be passed in the egg, nymph, or adult stage. Control measures consist of burning over or cultivating the adjoining grasslands; or dusting with 25 per cent calcium cyanide, or very strong nicotine dust.

AVOCADO PESTS OF LESSER IMPORTANCE
IN CALIFORNIA

The following species may be frequently seen on avocados in California, but are not generally of sufficient economic importance to warrant efforts at control. They are listed according to order and family.

- | | |
|---|--|
| Corrodentia, Psocidae: | <i>Pseudococcus nipae</i> Maskell, palm mealybug |
| Bark lice (species undetermined) | |
| Homoptera, Aphididae: | <i>Saissetia hemisphaerica</i> (Targ.), hemispherical scale |
| <i>Doralis (Aphis) gossypii</i> (Glover), melon or cotton aphids | |
| Homoptera, Coccidae: | Hemiptera, Pentatomidae: |
| <i>Ceroplastes cirripediformis</i> Comst., barnacle scale | <i>Murgantia histrionica</i> (Hahn), harlequin cabbage bug |
| <i>Ceroplastes cistudiformis</i> Towns. and Ckll. | Coleoptera, Chrysomelidae: |
| <i>Icerya purchasi</i> Maskell, cottony cushion, or fluted, scale | <i>Diabrotica soror</i> Lec., western twelve-spotted cucumber beetle |
| <i>Lecanium corni</i> Bouché, brown apricot scale | <i>Diabrotica balteata</i> Lec., belted cucumber beetle |
| <i>Phenacoccus colemani</i> Ehrh., Mexican mealybug | Coleoptera, Bostrichidae: |
| <i>Pseudococcus citri</i> (Risso), citrus mealybug | <i>Polycaon confertus</i> Lec., olive twig borer |
| <i>Pseudococcus gahani</i> Green, citrophilus mealybug | Lepidoptera, Gracilariidae: |
| <i>Pseudococcus longispinus</i> (Targ.), long-tailed mealybug | <i>Marmara</i> sp., avocado fruit and twig miner |
| <i>Pseudococcus maritimus</i> (Ehrh.), Baker's or grape mealybug | Lepidoptera, Noctuidae: |
| | <i>Heliothis obsoleta</i> Fabr., corn earworm |
| | <i>Lycophotia margaritosa</i> (Haworth), variegated cutworm |

AVOCADO PESTS OF THE WORLD

The following list of insects attacking the avocado in other states and countries has been compiled for the use of entomologists. The records are submitted here in order that the foreign species be known and that such action can be taken as may be necessary in case any are intercepted.

AFRICA

Thysanoptera, Thripidae:	Hemiptera, Miridae:
<i>Selenothrips (Heliothrips) rubrocinctus</i> Giard.	<i>Helopeltis</i> sp.
Homoptera, Coccidae:	Coleoptera, Bostrychidae:
<i>Ceroplastes floridensis</i> Comst.	<i>Apate terebrans</i> Pall.
<i>Chrysomphalus dictyospermi</i> (Morg.)	<i>Apate monacha</i> Fabr.
<i>Pulvinaria pyramidalis</i> Ckll.	Coleoptera, Cerambycidae:
<i>Saissetia perseae</i> Brain	<i>Batocera rubus</i> Linn.
Hemiptera, Coreidae:	Lepidoptera, Cossidae:
<i>Homococerus</i> sp.	<i>Zeuzera coffeae</i> Nietn.

BERMUDA

Acarina, Tetranychidae: *Paratetranychus* sp.

CENTRAL AMERICA

Homoptera, Coccidae:	Coleoptera, Curculionidae:
<i>Chrysomphalus scutiformis</i> (Ckll.)	<i>Sitophilus (Calandra) oryza</i> (Linn.)
Coleoptera, Cucujidae:	
<i>Cathartus advena</i> (Waltl.)	

CANAL ZONE

Homoptera, Coccidae:	Coleoptera, Curculionidae:
<i>Ceroplastes</i> sp.	<i>Heilipus perseae</i> Barber ¹²
<i>Ischnaspis longirostris</i> (Sign.)	<i>Pagiocerus rimosus</i> Eich.
<i>Pulvinaria pyramidalis</i> Ckll.	Lepidoptera, Xyloryetidae:
<i>Saissetia hemisphaerica</i> (Targ.)	<i>Stenoma catenifer</i> Wlsm.
<i>Targionia bifurcata</i> Ckll.	Lepidoptera, Saturniidae:
Homoptera, Aleyrodidae:	<i>Hylesia</i> sp.
<i>Aleurocanthus woglumi</i> (Ashby)	

COSTA RICA

Coleoptera, Curculionidae:	Lepidoptera, Pyralidae:
<i>Heilipus pittieri</i> Barber	<i>Stericta albifasciata</i> (Druce)

¹² *Heilipus perseae* is a very destructive avocado fruit weevil. For further information regarding this insect, see Dietz and Barber (1920).

GUATEMALA

Homoptera, Chermidae:	<i>Diaspis</i> sp.
<i>Trioza koebelei</i> Kirkaldy	<i>Lecanium</i> sp.
Homoptera, Aphididae:	<i>Lepidosaphes mimosarum</i> (Ckll.)
<i>Doralis (Aphis) gossypii</i> (Glover)	<i>Pseudoparlatoria ostreata</i> Ckll.
Homoptera, Coccidae:	<i>Pulvinaria floccifera</i> (Westw.)
<i>Aspidiotus lataniae</i> Sign.	<i>Solenococcus</i> sp.
<i>Aspidiotus subsimilis</i> Ckll.	Coleoptera, Curculionidae:
<i>Ceroplastes</i> sp.	<i>Caulophilus latinasus</i> Say
<i>Chrysomphalus dictyospermi</i> (Morg.)	<i>Conotrachelus perseae</i> Barber ¹³
<i>Chrysomphalus perseae</i> (Comst.)	Diptera, Trypetidae:
<i>Chrysomphalus personatus</i> (Comst.)	<i>Ceratitis capitata</i> (Wied.)
<i>Chrysomphalus scutiformis</i> (Ckll.)	Lepidoptera, Xyloryetidae:
<i>Coccus</i> sp.	<i>Stenoma</i> sp.
<i>Diaspis boisduvalii</i> Sign.	

HONDURAS

Thysanoptera, Thripidae: *Liothrips perseae* Watson

SALVADOR

Diptera, Trypetidae: *Anastrepha serpentina* Wied.

EAST INDIES

DUTCH EAST INDIES

Lepidoptera, Lasiocampidae:	Diptera, Trypetidae:
<i>Suana concolor</i> Walker	<i>Ceratitis capitata</i> (Wied.)

ENGLAND

Homoptera, Coccidae: *Pseudococcus maritimus* (Ehrh.) (in greenhouses)

FIJI ISLANDS

Homoptera, Coccidae: *Aspidiotus destructor* Sign.

FRANCE

Homoptera, Coccidae: *Aspidiotus lataniae* Sign.; *Aspidiotus palmarum* Morg. and Ckll.

GUAM

Coleoptera, Chrysomelidae: *Phytorus (Rhyparida) pinguis* Baly¹⁴

¹³ *Conotrachelus perseae* is a serious seed pest which often discolours the flesh of the fruit, thus rendering it inedible. For further information regarding this species, see Popenoe (1919).

¹⁴ Specimens of this species were sent to the author by J. W. Dale, who was stationed in Guam from 1933-35.

HAWAIIAN ISLANDS

- | | |
|--|--|
| Homoptera, Coccidae: | Diptera, Trypetidae: |
| <i>Aspidiotus persearum</i> Ckll. | <i>Ceratitis capitata</i> (Wied.) |
| <i>Pseudococcus nipae</i> Mask. | <i>Dacus</i> (<i>Chaetodacus</i>) <i>xanthodes</i> Broun |
| Homoptera, Aleyrodidae: | Lepidoptera, Xyloryctidae: |
| <i>Aleurocanthus woglumi</i> (Ashby) | <i>Stenoma catenifer</i> Wlsm. |
| Coleoptera, Scolytidae: | Lepidoptera, Tortricidae: |
| <i>Crossotarsus externedentatus</i> Fairm. | <i>Amorbia emigratella</i> Busck |
| <i>Hypothenemus eruditus</i> Westw. | |
| <i>Xyleborus immaturus</i> Blackb. | |

INDIA

- Lepidoptera, Cossidae: *Zeuzera coffeae* Nietn.

CEYLON

- | | |
|-------------------------------------|--------------------------------|
| Coleoptera, Cerambycidae: | Lepidoptera, Tortricidae: |
| <i>Batocera rubus</i> Linn. | <i>Homona coffearia</i> Nietn. |
| <i>Crocercops ordinatella</i> Meyr. | Lepidoptera, Cossidae: |
| Coleoptera, Scolytidae: | <i>Zeuzera coffeae</i> Nietn. |
| <i>Xyleborus fornicatus</i> Eich. | |

JAPAN

- Homoptera, Coccidae: *Aspidiotus persearum* Ckll.

MEXICO

- | | |
|---|---------------------------------------|
| Homoptera, Coccidae: | Coleoptera, Curculionidae: |
| <i>Ceroplastes cistudiformis</i> Towns. and Ckll. | <i>Conotrachelus aguacatae</i> Barber |
| <i>Chrysomphalus scutiformis</i> (Ckll.) | <i>Heilipus lauri</i> Boh. |
| <i>Icerya montserratensis</i> Riley and Howard | Lepidoptera, Xyloryctidae: |
| Homoptera, Chermidae: | <i>Stenoma catenifer</i> Wlsm. |
| <i>Trioza koebeleii</i> Kirkaldy | Lepidoptera, Pyralidae: |
| Hemiptera, Membracidae: | <i>Stericta albifasciata</i> (Druce) |
| <i>Hoplophora monogramma</i> Germar | |

PHILIPPINE ISLANDS

- | | |
|-------------------------------------|--|
| Homoptera, Coccidae: | Coleoptera, Scarabaeidae: |
| <i>Drosicha contrahens</i> Walker | <i>Euclea capito</i> Pasc. |
| <i>Saissetia formicarii</i> (Green) | <i>Niphonoclea</i> (<i>Euclea</i>) <i>albata</i> Newm. |
| Hemiptera, Miridae: | |
| <i>Helopeltis antonii</i> Watrh. | |

SAMOA

- Diptera, Trypetidae: *Dacus* (*Chaetodacus*) *xanthodes* Broun

SOUTH AMERICA

BRAZIL

- | | |
|---|--------------------------------------|
| Thysanoptera, Thripidae: | Homoptera, Aleyrodidae: |
| <i>Selenothrips (Heliothrips) rubrocinctus</i> Giard. | <i>Aleurotrachelus</i> sp. |
| Homoptera, Coccidae: | <i>Aleyrodes insignis</i> Bondar |
| <i>Aspidiotus destructor</i> Sign. | Coleoptera, Cerambycidae: |
| <i>Aspidiotus lataniae</i> Sign. | <i>Acanthoderes jaspidea</i> Germar |
| <i>Chrysomphalus personatus</i> (Comst.) | <i>Oncideres</i> sp. |
| <i>Chrysomphalus scutiformis</i> (Ckll.) | Lepidoptera, Xyloryctidae: |
| <i>Ischnaspis longirostris</i> (Sign.) | <i>Stenoma catenifer</i> Wlsm. |
| <i>Platinglisia noacki</i> Ckll. | Lepidoptera, Pyralidae: |
| <i>Pseudaonidia trilobitiformis</i> (Green) | <i>Stericta albifasciata</i> (Druce) |
| <i>Saissetia hemisphaerica</i> (Targ.) | |

BRITISH GUIANA

- | | |
|---|--|
| Thysanoptera, Thripidae: | <i>Chrysomphalus personatus</i> (Comst.) |
| <i>Heliothrips haemorrhoidalis</i> (Bouché) | <i>Pulvinaria pyriformis</i> Ckll. |
| Homoptera, Coccidae: | |
| <i>Aspidiotus destructor</i> Sign. | |

CHILE

- | | |
|---|--------------------------------------|
| Homoptera, Coccidae: ¹⁵ | Coleoptera, Curculionidae: |
| <i>Pseudococcus gahani</i> Green | <i>Pagiocerus rimosus</i> Eich. |
| <i>Saissetia oleae</i> (Bernard) | Lepidoptera, Psychidae: |
| Thysanoptera, Thripidae: | <i>Thanatopsyche chilensis</i> Phil. |
| <i>Heliothrips haemorrhoidalis</i> (Bouché) | |

ECUADOR

- Lepidoptera, Pyralidae: *Stericta albifasciata* (Druce)

FRENCH GUIANA

- Lepidoptera, Pyralidae: *Stericta albifasciata* (Druce)

PARAGUAY

- Coleoptera, Cerambycidae: *Oncideres fasciatus* Lucas

PERU

- | | |
|--------------------------------------|---------------------------|
| Lepidoptera, Pyralidae: | Hymenoptera, Formicidae: |
| <i>Stericta albifasciata</i> (Druce) | <i>Atta sexdens</i> Linn. |

SPAIN

- Homoptera, Coccidae: *Icerya montserratensis* Riley and Howard

TAHITI

- Coleoptera, Nitidulidae: *Carpophilus hemipterus* (Linn.)

¹⁵ Through the courtesy of H. Compere, information regarding these two species of scale insects, both of which are apparently new records, was made available. Of the two species, *Pseudococcus gahani* is the major pest of the avocado in Chile.

UNITED STATES OF AMERICA¹⁶

FLORIDA

- Thysanoptera, Thripidae:
Frankliniella cephalicus Craw.
Frankliniella cephalicus var. *bruneri* Watson
Frankliniella cephalicus var. *masoni* Watson
Heliothrips haemorrhoidalis (Bouché)
Selenothrips (Heliothrips) rubrocinctus Giard.
- Homoptera, Cicadellidae (Jassidae):
Empoasca minuenda Ball
- Homoptera, Coccidae:
Aspidiotus camelliae Sign.
Aspidiotus cyanophylli Sign.
Aspidiotus hederæ (Vallot)
Aspidiotus lataniae Sign.
Aspidiotus orientalis cocotiphagus (Marlatt)
Ceroplastes floridensis Comst.
Chrysomphalus agavis (Townsend and Ckll.)
Chrysomphalus aonidum (Linn.)
Chrysomphalus dictyospermi (Morg.)
Chrysomphalus perseæ (Comst.)
Coccus hesperidum Linn.
Fiorinia floriniæ (Targ.)
Hemichionaspis minor (Mask.)
Hemichionaspis sp.
Pseudoaonidia articulatus (Morg.)
Pseudischnaspis alienus (Newstead)
Pseudococcus citri (Risso)
Pseudococcus longispinus (Targ.)
Pseudococcus maritimus (Ehrh.)
Pseudococcus nipæ Mask.
- Pseudococcus virgatus* (Ckll.)
Pulvinaria psidii Mask.
Pulvinaria pyriformis Ckll.
Saissetia hemisphaerica (Targ.)
Saissetia oleæ (Bernard)
Tetralecia sp.
- Homoptera, Aleyrodidae:
Aleurocanthus woglumi (Ashby)
Paraleurodes perseæ Quaint.
Trialeurodes floridensis (Quaint.)
- Hemiptera, Pyrrhocoridae:
Dysdercus suturellus H. and S.
- Hemiptera, Tingidae:
Acysta perseæ Heid.
- Coleoptera, Scarabaeidae:
Anomala undulata Mels.
- Coleoptera, Cerambycidae:
Elaphidion inerme Newm.
Lypsinena fuscata Lee.
- Coleoptera, Curculionidae:
Araocerus fasciculatus DeG.
Caulophilus latinasus Say
Conotrachelus serpentinus Boh.
(Cryptorhynchus) Apteromechus ferratus (Say)
- Lepidoptera, Noctuidae:
Sparganothis sp.
Xylomyges eridania Cram.
- Lepidoptera, Gracilariidae:
Gracilaria perseæ Busek
Gracilaria violacella Clem.
- Acarina, Tetranychidae:
Paratetranychus yothersi McG.

MARYLAND

- Acarina, Tetranychidae: *Oligonychus major* Ewing

WEST INDIES

- Homoptera, Coccidae:
Aspidiotus destructor Sign.
Ceroplastes floridensis Comst.
Chrysomphalus dictyospermi (Morg.)
Iceya montserratensis Riley and Howard
Pulvinaria pyriformis Ckll.
Saissetia hemisphaerica (Targ.)
Saissetia nigra (Nietn.)
Saissetia oleæ (Bernard)
Sclenaspis articeulatus (Morg.)
Targionia bififormis (Ckll.)

¹⁶ Localities discussed under this heading do not include California. See preceding sections of bulletin.

Coleoptera, Bostrychidae:

Apate monacha Fabr.

Coleoptera, Cerambycidae:

Batocera rubus Linn.

Coleoptera, Curculionidae:

Diaprepes abbreviatus Linn.

Lepidoptera, Megathymidae:

Calpodes ethlius Cram.

BARBADOS

Isoptera, Termitidae:

Constrictotermes incisus Snyder

Homoptera, Coccidae:

Chrysomphalus dictyospermi (Morg.)*Pseudococcus nipae* Mask.*Pulvinaria pyriformis* Ckll.

Coleoptera, Curculionidae:

Diaprepes abbreviatus doublieri

Guerni

Diaprepes sprengheri Linn.

Lepidoptera, Cossidae:

Duomitus punctifer Hamp.

CUBA

Thysanoptera, Thripidae:

Frankliniella cephalicus bruneri Watson*Frankliniella tritici* (Fitch)*Heliothrips haemorrhoidalis* (Bouché)

Homoptera, Coccidae:

Aspidiotus destructor Sign.*Toumeyella* sp.

Homoptera, Aleyrodidae:

Aleurocanthus woglumi (Ashby)

Coleoptera, Bostrychidae:

Apate carmelita Fabr.

Coleoptera, Curculionidae:

Pachnaeus litus (Germar)

Coleoptera, Scolytidae:

Pagiocerus rimosus Eich.

Lepidoptera, Bombycidae:

Oiketicus poeyi Lucas

Hymenoptera, Formicidae:

Atta insularis Guerni

PUERTO RICO

Isoptera, Termitidae:

Nasutitermes (Eutermes) morio Latr.

Homoptera, Cicadellidae:

Empoasca minuenda Ball

Homoptera, Coccidae:

Aspidiotus destructor Sign.

Coleoptera, Scarabaeidae:

Lachnosterna (Phyllophaga) sp.

Coleoptera, Curculionidae:

Diaprepes abbreviatus Linn.

SAINT THOMAS

Homoptera, Coccidae: *Aspidiotus articulatus* (Morg.) ; *Aspidiotus palmae* Morg. and Ckll.

TRINIDAD AND TOBAGO

Thysanoptera, Thripidae:

Heliothrips haemorrhoidalis (Bouché)*Selenothrips (Heliothrips) rubrocinctus* Giard.

Homoptera, Coccidae:

Aspidiotus destructor Sign.*Pseudococcus citri* (Risso)*Pseudococcus nipae* Mask.*Pulvinaria pyriformis* Ckll.*Saissetia nigra* (Nietn.)

Homoptera, Aleyrodidae:

Aleurodicus neglectus Quaint.

Lepidoptera, Pyralidae:

Stericta albifasciata (Druce)

Hymenoptera, Formicidae:

Solenopsis geminata (Fabr.)

VIRGIN ISLANDS

Coleoptera, Cerambycidae: *Batocera rubus* Linn.

BIBLIOGRAPHY

ASHMEAD, W. H.

1893. A monograph of the North American Proctotrypidae. U. S. Natl. Mus. Bul. 45:1-472. (See specifically pp. 142-143.)

BARBER, H. S.

1919. Avocado seed weevils. Ent. Soc. Washington Proc. 21:53-60.
1923. Two new *Conotrachelus* from tropical fruits (Coleoptera, Curculionidae). Ent. Soc. Washington Proc. 25:182-185.

BARRETT, R. E.

1931. A new pest of the avocado in California. Pan-Pacific Ent. 7:191.

BORDEN, A. D.

1932. Codling-moth bait traps. California Agr. Ext. Cir. 63:1-13.

BRAIN, C. K.

1920. The Coccidae of South Africa. Bul. Ent. Research 11:1-440. (See specifically pp. 1-42.)

BUSCK, A.

1929. A new avocado moth (Lepidoptera, Fm. Tortricidae), *Amorbia essigana*, new species. California State Dept. Agr. Mo. Bul. 18:276-277.

CALIFORNIA STATE DEPARTMENT OF AGRICULTURE.

1927. Broad-nosed grain weevil taken. California State Dept. Agr. Mo. Bul. 16:540-543.

CHITTENDEN, F. H.

1901. Some insects injurious to the violet, rose, and other ornamental plants. U. S. Dept. Agr. Bur. Ent. Bul. 27:1-114. (See specifically pp. 88-96.)
1910. Some insects injurious to truck crops. Notes on the cucumber beetles. U. S. Dept. Agr. Bur. Ent. Bul. 82(Pt. 6):69-75.
1911. The broad-nosed grain weevil. The long-headed flour beetle. U. S. Dept. Agr. Bur. Ent. Bul. 96(Pt. 2):19-28.

COCKERELL, T. D. A.

1897. The San Jose scale and its nearest allies. U. S. Dept. Agr. Div. Ent. Tech. Ser. 6:1-31.
1900. Some Coccidae quarantined at San Francisco. Psyche 9:70-72.

COIT, J. E.

- 1924-25. Experiments on control of June beetles (*Serica fimbriata*) on avocado trees. California Avocado Assoc. Ann. Rept. 1924-25:23.
1928. Pests and diseases of the avocado. California Avocado Assoc. Ann. Rept. 1928:18-21.
1929. Thrips and their control. California Avocado Assoc. Ann. Rept. 1929:130.

COLE, F. R.

1931. How the Whittier Laboratory can be of service to the avocado industry. California Avocado Assoc. Ann. Rept. 1931:100-101.

COMSTOCK, J. A.

1929. Studies in Pacific coast Lepidoptera. South. California Acad. Sci. Bul. 28:50-58.

COMSTOCK, J. H.

1916. Reports on scale insects. New York (Cornell) Agr. Exp. Sta. Bul. 372:425-603. (See specifically pp. 507-603.)

CONDIT, I. J.

1919. Insect pests of the avocado. California State Hort. Comm. Mo. Bul. 8:27-29.

COSTA LIMA, A. DA

1923. Insectes inimigos do abocateiro—*Persea gratissima*, no Brazil. [Insect pests of the avocado in Brazil.] Chacaras e Quintaes 27:304-308.

CRAWFORD, J. C.

1910. Descriptions of certain chalcidoid parasites. U. S. Dept. Agr. Bur. Ent. Tech. Bul. 19 (Pt. 2):13-24.

CRESSMAN, A. W.

1933. Biology and control of *Chrysomphalus dictyospermi* (Morgan). Jour. Econ. Ent. 26:696-706.

CUSHMAN, R. A.

1914. A revision of the North American species of the braconid genus *Habrobracon* Johnson (Ashmead). Ent. Soc. Washington Proc. 16:99-108.

DIETZ, H. F., and H. S. BARBER.

1920. A new avocado weevil from the Canal Zone. Jour. Agr. Research 20:111-116.

DIETZ, H. F., and H. MORRISON.

1916. The coccidae or scale insects of Indiana. 321 p. Office of State Entomologist, Indianapolis.

DOZIER, H. L.

1927. Some new and interesting Porto Rican leafhoppers. Jour. Dept. Agr. Porto Rico 10:259-265.

DUTTON, E. C.

1930. Dictyospermum scale. California Avocado Assoc. Ann. Rept. 1930:128-129.

DYAR, H. G.

1902. A list of the North American Lepidoptera and key to the literature of this order of insects. U. S. Natl. Mus. Bul. 52:1-723. (See specifically p. 346.)
1912. Note on a *Stericta* from tropical America (Lepidoptera, Pyralidae). Ent. Soc. Washington Proc. 14:66.

ESSIG, E. O.

1915. Injurious and beneficial insects of California. California State Comm. Hort. Mo. Bul. Sup. 2nd ed. 541 p. (See specifically pp. 417-419, figs. 424-428.) California State Printing Office, Sacramento.
1916. Two newly established scale insects. California State Hort. Comm. Mo. Bul. 5:192-197.
1926. Insects of western North America. 1035 p. (See specifically pp. 701-703.) The Macmillan Company, New York.

EWING, H. E.

1921. New nearctic spider mites of the family Tetranychidae. U. S. Natl. Mus. Proc. 59:659-666.

FERNALD, M. E.

1903. A catalogue of the Coccidae of the world. 360 p. (See specifically pp. 266-267.) Carpenter and Morehouse, Amherst, Mass.

FISHER, H. C.

1920. Report of the Health Department of the Panama Canal for the calendar year 1919. 134 p. Panama Canal Press, Canal Zone.

GENIEYS, P.

1925. *Habrobracon brevicornis* Wesm. Ann. Ent. Soc. Amer. 18:143-202.

GONZALES RIOS, P., and A. MAYORAL REINAT.

1931. El cultivo del aguacate en Puerto Rico. [The cultivation of the avocado in Puerto Rico.] Puerto Rico Insular Exp. Sta. Cir. 93:1-34.

GREEN, E. E.

1896-1922. The Coccidae of Ceylon. 5 vol. (See specifically pp. 49-50.) Dulau and Co., London.

GUENÉE, M. A.

1857. Histoire naturelle des insectes. Species general des Lepidoptères. 10 vol. Roret, Paris. (Reviewed in: Dyar, H. G., A list of North American Lepidoptera. U. S. Natl. Mus. Bul. 52:346.)

HEMPEL, A.

1900. As Coccidas brazileiras. [Coccidae of Brazil.] Rev. Mus. Paulista [Sao Paulo] 4:365-537.

HODGSON, R. W.

1934. The California avocado industry. California Agr. Ext. Cir. 43:1-94. Revised ed. (See specifically pp. 42-51.)

HULST, G. D.

1894-95. Notes on types of North American Geometrina in European collections. I. Ent. News 5:302-306; 6:11-15.

JACOBSEN, W. C.

1927. Dietyospermum scale in California. California Avocado Assoc. Ann. Rept. 1927:48-50.

KEIFER, H. H.

1931. Notes on some California Lepidoptera of economic interest. California State Dept. Agr. Mo. Bul. 20:613-626.

KUWANA, S. J.

1902. Coccidae from the Galapagos Islands. Jour. New York Ent. Soc. 10:28-33.

LEONARDI, G.

1897-1900. Generi e specie di Diaspiti. Saggio di sistematica degli *Aspidiotus*. [Genera and species of diaspine scales. Systematics of *Aspidiotus*.] Riv. Patol. Veg. 6:102-134, 208-236; 7:38-86, 173-225; 8:298-363.

MACKIE, D. B.

1931. A report of the coccids infesting avocados in California, with special reference to *Chrysomphalus dictyospermi* (Morgan). California State Dept. Agr. Mo. Bul. 20:419-441.

MARLATT, C. L.

1929. Report of Chief of United States Department of Agriculture Bureau of Entomology. 1929:1-39.

MCGREGOR, E. A.

1914. Four new Tetranychids. Ann. Ent. Soc. Amer. 7:354-364.

McKENZIE, H. L.

1933. Latest developments in avocado pest control. California Avocado Assoc. Ann. Rept. 1933:33-36.

McLEAN, R. R.

1931a. Insect pests and plant diseases of the avocado in California. California State Dept. Agr. Mo. Bul. 20:442-446.

- 1931b. Pest control—the growing problem of the industry. California Avocado Assoc. Ann. Rept. 1931:69–80.

MOZNETTE, G. F.

1919. Annotated list of the injurious and beneficial insects of the avocado in Florida. Florida Buggist 3:45–48.
- 1919–20. Some important insects which attack the avocado in Florida. California Avocado Assoc. Ann. Rept. 1919–20:76–78.
1920. The dictyospermum scale on the avocado and how it may be controlled. Florida State Plant Bd. Quart. Bul. 5:5–11.
- 1921a. Dusting vs. spraying for the control of insect pests on the avocado. Jour. Econ. Ent. 14:465–469.
- 1921b. Some insect problems confronting the avocado grower. Jour. Econ. Ent. 14:341–344.
- 1921–22. The possibility of transmitting insects on budwood with special reference to the avocado. California Avocado Assoc. Ann. Rept. 1921–22:56–57.
- 1922a. The avocado: its insect enemies and how to combat them. U. S. Dept. Agr. Farmers' Bul. 1261:1–31.
- 1922b. The red spider on the avocado. U. S. Dept. Agr. Bur. Ent. Bul. 1035:1–15.

NEL, R. G.

1933. A comparison of *Aonidiella aurantii* and *Aonidiella citrina*, including a study of the internal anatomy of the latter. Hilgardia 7(11):417–466.

NEWELL, W.

1899. On the North American species of the subgenera *Diaspidiotus* and *Hemiberlesia*, of the genus *Aspidiotus*. Iowa Agr. College, Contrib. Zool. and Ent. 3:1–31.

OGILVIE, L.

1925. Chief plant diseases and pests observed during the year. Bermuda Bd. and Dept. Agr. Repts. 1924:36–43.

POFENOE, W.

1919. The avocado in Guatemala. U. S. Dept. Agr. Dept. Bul. 743:1–69.

QUAYLE, H. J.

1911. The red or orange scale. California Agr. Exp. Sta. Bul. 222:99–150. (Out of print.)
1931. Control of latania scale (*Aspidiotus lataniae* Sign.). California Avocado Assoc. Ann. Rept. 1931:97–100.
- 1932a. Biology and control of citrus insects and mites. California Agr. Exp. Sta. Bul. 542:1–87.
- 1932b. Control of avocado scale. California Avocado Assoc. Ann. Rept. 1932:40–43.
- 1932c. Progress report on avocado insect pest investigations. California Avocado Assoc. Ann. Rept. 1932:46–48.
- 1932d. The trend of avocado pests and their control. California Avocado Assoc. Ann. Rept. 1932:38–39.

RYAN, H. J.

1930. County Agricultural Commissioners' Notes, Los Angeles County. California State Dept. Agr. Mo. Bul. 19:68–69.

RYERSON, K. A.

1928. Avocado culture in California. Part I. History, culture, varieties, and marketing. California Agr. Exp. Sta. Bul. 365:1–69. Revised by R. W. Hodgson. (Out of print.)

SIGNORET, V. A.

1869. Essai sur les Cochenilles. [Treatise on the Coccidae.] Ann. Soc. Ent. France (ser. 4) 9:97-138. (See specifically *Aspidiotus lataniae*, p. 124, pl. 5, figs. 12 and B.)

SMITH, H. S., *et al.*

1933. The efficacy and economic effects of plant quarantines in California. California Agr. Exp. Sta. Bul. 553:1-276.

SMITH, R. H.

1929. Thrips injury to avocados. California Avocado Assoc. Ann. Rept. 1929:130.

TAKAHASHI, R.

1928. Coccidae of Formosa. Philippine Jour. Sci. 36:327-347.

TYLER, C. H.

1896. Some Mexican and Japanese injurious insects liable to be introduced into the United States. U. S. Dept. Agr. Div. Ent. Tech. Ser. 4:1-56.

URICH, F. W.

1919. Insects affecting the avocado in Trinidad and Tobago. Trinidad and Tobago Dept. Agr. Bul. 28:129-131.

WALKER, F.

1860. List of the specimens of Lepidopterous insects in the collection of the British Museum. 28 parts. Trustees of the British Museum, London. (See specifically part 20, p. 34.)

WATSON, J. R.

1921. Notes on some Florida weevils. Florida Entomologist 4:33-35.

WOLCOTT, G. N.

1929. The status of economic entomology in Peru. Bul. Ent. Research 20 (Pt. 2): 225-231.
1933. An economic entomology of the West Indies. 688 p. Entomological Society of Puerto Rico, San Juan.

WOODWORTH, C. W.

1913. Guide to California insects. 360 p. The Law Press, Berkeley, California.